



Spaceflight Medical Evacuation Risk Assessment Principles: *A Qualitative Investigation from Space and Analog Environments*

Human Research Program
Exploration Medical Capability Element

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“Expanding the Boundaries of Space Medicine and Technology”

- Overview
- Research Question
- Study Objectives
- Research Goal
- Research Team
- Methodology
- Status, Preliminary Results/Findings, and Forward Work

- What unique principles must be considered for medical evacuation (MEDEVAC*) decisions in extreme environments?

*MEDEVAC = Medical Evacuation; Distinguished from “CASEVAC” or “casualty evacuation” and “AIREVAC” (formal “aeromedical evacuation”) as described in the military environment

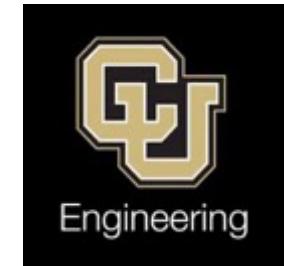
- ID Common principles used to assess risks and benefits of MEDEVAC in extreme environments
- ID common challenges and complications of MEDEVAC in extreme environments

Inform MEDEVAC and medical system design for Moon and Mars

Research Team



- Austin Almand, MS Project Lead ExMC Intern / CU-Anschutz MD Candidate
- Benjamin Easter, MD Primary Investigator ExMC Acting Element Scientist / CU-Anschutz Asst. Prof.
- Jonathan Laws, MS Qualitative Design SME Northumbria University PhD Candidate
- Arian Anderson, MD Interviewer / Reviewer ExMC Clinical and Science Team Physician
- Ryan Keller Contributor Baylor College of Medicine MD Candidate
- Michael Zero, MS Reviewer CU-Boulder PhD Candidate
- Kris Lehnhardt, MD Sponsor ExMC Element Scientist / Baylor COM Sen. Faculty



Methodology

- In-depth semi-structured interviews with subject matter experts (SMEs)
- Qualitative *thematic analysis* using *consensus, co-occurrence and comparison*
- Sample sizes follow a *step-wise approach* seeking *saturation* for each analog domain
- Analogs determined by mission, MEDEVAC complexity and local medical capability

Execution

- SMEs ID'd and invited for a recorded video interview (Zoom, Teams, phone)
- Audio anonymized, transcribed, and analyzed for emerging themes
- Emerging themes and conclusions reviewed by research team for validity

Images (L-to-R) courtesy NASA, US Air Force, US DoE, US Navy, NASA, and Lloyd Smith via the public domain and Creative Commons



Status

- 18 SME interviews analyzed
 - 2 Alpine/Wilderness
 - 5 Polar
 - 4 Combat
 - 3 Military Submarine
 - 2 Underwater
 - 2 Spaceflight
- 1200+ min of interviews transcribed, coded, analyzed



Image courtesy NASA Goddard



Image courtesy US Army

Preliminary Results

- 9 MEDEVAC risk consideration themes
- 9 contributing factor themes

Primary Risks Themes

- **Patient(s)** – number, stability, expected clinical course
- **Experience** – clinical decision making, team rehearsal
- **Execution** – stability of patient, difficulty of transfer
- **Crew** – during, post MEDEVAC, increased burden
- **Environment** – risks to crew and vehicles, risks over time
- **Mission** – mission viability, Context determines MEDEVAC
- **Time** – transport, execution, stability
- **Medical Provider** – importance, duty, fatigue
- **Resources** – personnel, vehicles, equipment, supplies

“patient life or lifelong disability , that really is the primary consideration”

“we have to not fear death but embrace death and accept death as as a reality . And we're just not there as a society”

“don't create more people needing to be rescued”

“the resources, the training, the appropriate equipment to make the stay play worthwhile”

Contributing Factors Themes

- **Communication** – Reliability, Consistency, Information lost
- **MEDEVAC Planning** – preplanned vs. ad hoc
- **Medical Support Planning** – native, resupply, tiered
- **Offsite Support** – telemedicine, decision support
- **Philosophy** – stay and play vs. load and go
- **Crew Cohesion** – teamwork, interpersonal awareness
- **Political Considerations** – optics, funding
- **Psychological Considerations** – hero complex, psychological fitness, guilt
- **Decision Making** – medical vs. operational decision makers, centralized vs. decentralized

"The constant rehearsal is a huge one"

"I have never been on a single mission or been a part of any mission where any of the information that initially came out was better than 50 percent accurate"

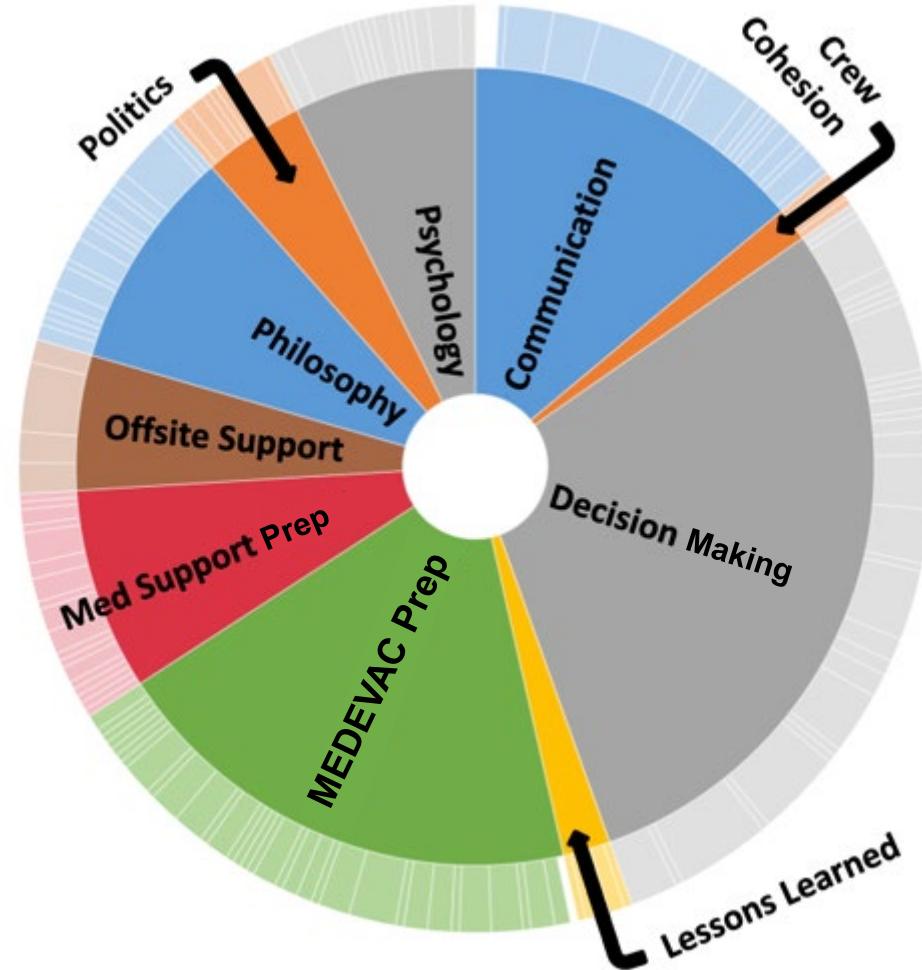
"Disjunctions happen in small towns, but for the most part, we all get along"

"if it had gone wrong, I mean, the stock price could have gone way down"

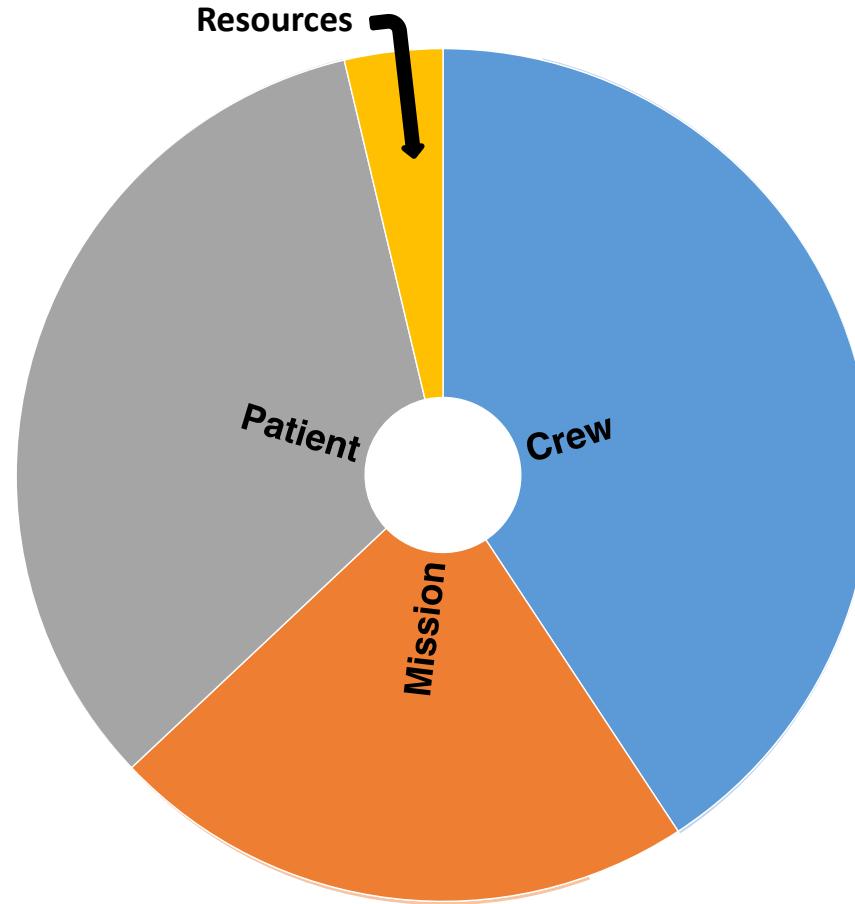
Primary Risks



Contributing Factors



Top Priority Choice for MEDEVAC



"the highest consequence thing would be to make sure that the evacuation doesn't cross a risk threshold for the providers"

"what is in the best interest of the patient with everything else kind of as contributing"

"Our mission was so critical that they were essentially accepting that somebody would be lost on their on their watch"

"First and foremost, what is the capability of the evac team ?"

Takeaways

- Preparation + Philosophy + Decision Making : Set the scene
- Patient(s) + Resources + Experience : The MEDEVAC “math”
- Crew vs. Patient...

Impacts

- Framework for medical system design and contingency planning
- Inform training and preparation for crew and organization at large
- Tool for real-time MEDEVAC decision support

Execution

- Complete interviews with SME's in Space domains

Analysis

- Revise, refine and consolidate findings
- Disseminate to team for review
- Draft and submit manuscript for review/publication

Application

- Stakeholders discussion
- Define principles for new decision and planning tool

ExMC Research Team Participants